SDLL107 - Transient computation of a beam under random excitation

Abstract:

The purpose of this benchmark is to calculate the temporal response of a beam under random excitation of power spectral density (DSP) and whose displacements are limited in several points by obstacles:

- The beam is subjected has random requests,
- the obstacle is characterized by a normal stiffness of shock and a coefficient of kinetic friction.

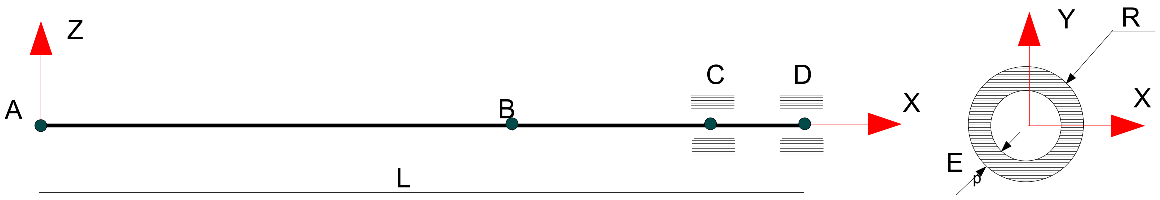
One determines, on the level of the obstacles, several quantities characterizing the behavior:

- Average displacement,
- Value RMS of the normal force,
- Mean value of the tangent force,
- Power of wear

This test is carried out on a beam made up of elements SEG2 and circular section.

1 Problem of reference

1.1 Geometry



Geometry of beam: (m)

$L=1.5$
$R=0.005$
$e_p=0.0005$

Coordinates of the points (m) :

$A:(0.0,0.0,0.0)$
$B:(1.,0.0,0.0)$
$C:(1.38,0.0,0.0)$
$D:(1.5,0.0,0.0)$

1.2 Elastic properties of the material

- $E=2.0E11\ Pa$ Modulus Young
- $\nu=0.3$ Poisson's ratio
- $\rho=7900.0\ kg.m^{-3}$ Density

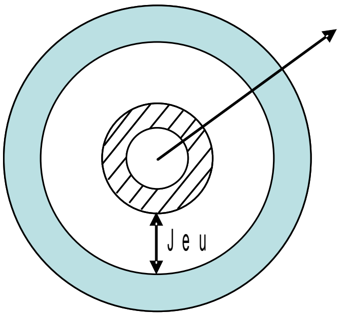
1.3 Boundary conditions and loadings

- imposed Displacement:
- All nodes: $DRX=DRY=DX=DZ=0.0$
- Point: A $DY=DRZ=0.0$

- Imposed loading:
- Point: B random force according to Y
- Point: B random moment around Z

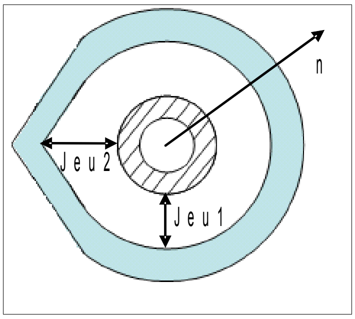
•Obstacle (CERCLE) with point: D

- •Clearance = $0 \quad m$
- •norm = $(1.,0.,0.)$
- •origin = $(1.,0.,0.)$
- •normal Stiffness: $RIGI\_NOR=10^6 N/m$
- •Friction COULOMB : $COULOMB=0.3$



•Obstacle (DISCRETE) with point: C

- •= origin $(1.,0.,0.)$
- •normalizes = $(1.,0.,0.)$
- •normal Stiffness: $RIGI\_NOR=100. N/m$
- •Friction COULOMB : $COULOMB=0.3$



- •Jeu1 = $1.0 \quad m$
- •Jeu2 = $1.5 \quad m$

2 Reference solution

2.1 Computation of reference

One uses a reference NON_REGRESSION to test the various quantities calculated on the level of the obstacles.

The procedure of computation is the following one, one:
- Calculate modal base,
- Creates interspectral matrix (or DSP) from complex functions,
- Generates the random forces,
- Calculates response transient dynamics,
- Test of the values of the response (displacements and forces) to the level of the obstacles.

2.2 Reference variable

Components of the interspectral matrix obtained starting from the complex functions.

Component	quantity	AVERAGE
Comments	DEPL_X	Mean value of following displacement X , at the point of shock, in their local coordinate system,
DEPL_Y	ECART_TYPE	Value of the standard deviation of following displacement Y , at the point of shock, in their local coordinate system,
DEPL_RADIAL	RMS	Value RMS over the time of shock of “radial displacement” at the point of shock.
Maximum	DEPL_ANGULAIRE	MAXI Value of “angular displacement” at the point of shock.
FORCE_NORMALE	RMS_T_TOTAL	Value RMS over the total time of the normal force at the point of shock.
AVERAGE	FORCE_TANG_1	Mean value of the tangent force in the plane of the obstacle.
FORCE_TANG_2	ECART_TYPE	Value of the standard deviation of the tangent force orthogonal to plane of the obstacle.
STAT_CHOC	T_CHOC_MOYEN	Time of shock average
STAT_USURE	PUIS_USURE	Power of wear calculated according to ARCHARD.

2.3 Result of Component

	reference	Reference
Interspectral matrix	$(1,1)$	$0.1000+0.j$
	$(2,2)$	$0.025+0.j$

Note :
the behavior of the generator of random numbers (modulus `RANDOM`*) changed since the versionde* 2.3 *python. The results are some a little affected. For the tests on the response transient dynamics, one thus tests with quantities and results of reference different according to the versions from python.*

Version python lower than 2.3			
Component	Quantity	Point	Reference
DEPL_X	AVERAGE	D	$0.5\,m$
DEPL_Y	ECART_TYPE	D	$2.57\times10^{-5}\,m$
DEPL_RADIAL	RMS	D	$2.573\times10^{-5}\,m$
FORCE_NORMALE	RMS_T_TOTAL	D	$25.73\,N$

Version python higher than 2.3			
Component	Quantity	Point	Reference
DEPL_X	AVERAGE	D	$0.5\,m$
DEPL_Y	ECART_TYPE	D	$2.456\times10^{-5}\,m$
DEPL_RADIAL	RMS	D	$2.456\times10^{-5}\,m$
FORCE_NORMALE	RMS_T_TOTAL	D	$24.56\,N$
DEPL_ANGULAIRE	MAXI	C	$180.\,rad$
FORCE_TANG_1	AVERAGE	D	$0.$
FORCE_TANG_2	ECART_TYPE	D	$0.$
STAT_CHOC	T_CHOC_MOYEN	C	$0.$
STAT_USURE	PUIS_USURE	C	$0.$

3 Modelization A

3.1 Characteristic of the modelization A

Modelization POU_D_T :

Many nodes 76
Number of meshes 75 Are:
SEG2 75

Mesh group:

LIS1 : together meshes SEG2 of the beam

3.2 Quantities tested and results

	Component	Reference	Tolerance (%)
Interspectral matrix	(1,1)	0.100+0.j	10
Interspectral matrix	(2,2)	0.025+0.j	10

3.2.1 Version python lower than 2.3

Component	Quantity	Point	Reference	Tolerance (%)
DEPL_Y	ECART_TYPE	*D*	$2.57\times10^{-5}\ m$	0.1
DEPL_RADIAL	RMS	*D*	$2.573\times10^{-5}\ m$	0.1
FORCE_NORMALE	RMS_T_TOTAL	*D*	$25.73\ N$	0.1

3.2.2 Version python higher than 2.3

Component	Quantity	Point	Reference	Tolerance (%)
DEPL_Y	ECART_TYPE	*D*	$2.456\times10^{-5}\ m$	0.1
DEPL_RADIAL	RMS	*D*	$2.456\times10^{-5}\ m$	0.1
FORCE_NORMALE	RMS_T_TOTAL	*D*	$24.56\ N$	0.1
DEPL_ANGULAIRE	MAXI	*C*	$180.\ rad$	0.1
FORCE_TANG_1	AVERAGE	*D*	0.	0.1
FORCE_TANG_2	ECART_TYPE	*D*	0.	0.1
STAT_CHOC	T_CHOC_MOYEN	*C*	0.	0.1
STAT_USURE	PUIS_USURE	*C*	0.	0.1

4 Summary of the results

the got results are satisfactory, they allow validate the case test.